SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM SENSOR EVALUATION

TECHNOLOGY NEED

The cone penetrometer is the most cost-effective and rapid tool for environmental site characterization in unconsolidated and semi-consolidated formations. In its standard configuration, the cone penetrometer is recognized as the most efficient tool for delineating lithology and stratigraphy in sedimentary formations. Currently, many sensors and probes for use with the cone penetrometer are currently under development that can be used to extend the capabilities of cone penetrometer trucks to the 'real-time' detection of contamination in the subsurface. Although many of these sensors can provide better information in a cost- and time-effective manner, they are often not chosen by environmental line organizations due to the limited availability of independent cost and performance data. The activities on this task focus on the collection of cost and performance data as well as technical and engineering assistance for application of these technologies to real problems at DOE sites.

During FY 1998, the sensors chosen for evaluation under this program target a very high priority characterization and monitoring needs within DOE, specifically, inset detection of Dense Non-Aqueous Phase Liquids (DNAPL) in the subsurface. Residual industrial solvents are currently the most significant challenge for the successful completion of many large groundwater and soil cleanup efforts. Slowly dissolving DNAPL provide a major source of groundwater contamination for hundreds of years and traditional sampling approaches generally are not successful at locating DNAPL. Adding to the challenge, is the fact that DNAPL is very difficult to characterize in the subsurface--especially when it is found in dispersed blobs as is typical at many sites. The current DOE Site Technology Needs document identifies over twenty waste sites where characterization of DNAPL is a priority. The current baseline method for DNAPL characterization involves collection of a large number of sediment cores, a process that is expensive, time-consuming, often ineffective, and has the potential for creating pathways that enhance the downward migration of contaminants. Identification of successful techniques for *in situ* DNAPL characterization will significantly reduce costs and substantially improve the quality of characterization and monitoring efforts at sites contaminated or potentially contaminated with DNAPL.

TECHNOLOGY DESCRIPTION

A Site Characterization and Analysis Cone Penetrometer System (SCAPS) truck was built for the DOE by the Army Corps of Engineers The DOE SCAPS truck , referred to as the Cone Penetrometer Truck (CPT), is currently operated by a vendor under contract to WSRC and is used primarily for the following purposes:

- Evaluation and demonstration of innovative CPT sensors.
- Demonstration and implementation of sensors developed by the Federal Energy Technology Center (FETC) Industrial Program.

Three sensors, including two Raman sensors for direct detection of DNAPL and a down-hole video microscope, will be evaluated In FY 1998 as part of the sensor evaluation program. These sensors potentially could extend the capability of the CPT to direct qualitative detection of DNAPL in the subsurface.

An additional three sensors developed with funding from the Federal Energy Technology Center's Industrial Program, the Science and Engineering Associates, Inc. (SEA) Cone Permeameter System, the EIC Inc. (EIC), Internal Reflection Sensor, and the Applied Research Associates, Inc. (ARA) Geophysical Tomography system will be field-tested to collect cost and performance data and will be implemented at the Environmental Restoration waste sites at the Savannah River Site (SRS).

- The Cone Permeameter, a CPT probe developed by SEA that measures *in situ* depth discrete estimates of permeability. This information is critical for the design and optimization of remediation systems.
- A CPT-deployed geophysical system developed by ARA that combines electrical resistance tomography with ground penetrating radar for delineation of the subsurface and possibly *in situ* detection of contamination. Electrical resistance tomographic systems have proven to be very robust for characterization and monitoring of small scale remediation systems. This system combines two geophysical sensors to extend the resolution and range of applicability of the system.
- A fiber optic based internal reflectance sensor developed by EIC for direct detection of the DNAPL. This system has the potential to significantly reduce the cost of *in situ* detection systems in certain environments.

BENEFITS

The use of the SCAPS truck for environmental characterization and monitoring is favored over baseline drilling and sampling because cone penetrometer systems:

- Provide continuous, real-time, subsurface information to aid in site characterization.
- Minimize disturbance to the subsurface as no drilling fluids are used and the push-hole diameters are quite small (1 to-2 inches).
- Cost considerably less than conventional drilling and sampling methods.
- Offer the advantage of real-time data analysis so that the push location can be selected based on the results of holes already pushed.
- Can be used with sensors to measure various types of chemical contaminants and other physical characteristics of the subsurface.
- Are safer than conventional drilling because worker exposure is minimized due to faster subsurface access and generation of minimal amounts of waste.
- Make possible rapid and cost-effective definition of contaminant plumes thus enabling more accurate placement of remediation systems and monitoring wells.

This year's evaluation activities focus on extending the capability of CPT systems for direct detection of DNAPL. Combining the qualitative information for multiple sensors may allow for development of a relatively robust system for real-time detection of DNAPL.

In addition, under this task, field evaluation and implementation assistance will be provided to the FETC for three of their environmental technologies that are at the technology demonstration stage of development. In FY 1997, the Savannah River Technology Center (SRTC) evaluated four FETC technologies, three of which are now in use by end-users at SRS.

CAPABILITIES/LIMITATIONS

When considering the selection of CPT at a particular site, the technology should be compared with standard drilling and chemical analysis procedures in use at the site. CPT methods will not replace standard sampling and analysis for site characterization and monitoring, but they will provide a way to optimize sample collection and analysis. The use of CPT is dependent on appropriate geologic conditions to ensure penetration to the required depths.

The continuous nature of CPT investigations allows the use of screening technologies that measure information on a depth-discrete scale. These technologies provide the most accurate possible information about the precise intervals where contamination occurs leading to optimized remediation design. The real-time nature of the information allows for better use of characterization and monitoring resources and improves the quality of the characterization. The CPT technologies are limited to unconsolidated sediments and to the maximum depth capability of the CPT truck. The contaminant data are also limited by the lack of regulatory acceptance.

COLLABORATION/TECHNOLOGY TRANSFER

This work is a collaboration between various federal agencies, universities and private industry. Principal partners include: Fugro, Geosciences; EIC; Department of Defense (DoD)/Air Force Center for Environmental Excellence (AFCEE), SEA, ARA, Dakota Technologies, and DoD/Naval Command, Control, and Ocean Surveillance Center (NCCOSC).

ACCOMPLISHMENTS

- Documented performance data in an Innovative Technology Summary Report (ITSR) of the Technology Demonstrations: ARA Sonic CPT system.
- Evaluated the Raman Probe technology developed by Lawrence Livermore National Laboratory(LLNL), the Raman Probe developed by EIC, and the *In situ* Video Microscope developed by NCCOSC (DoD).

Other related DOE program support:

- Evaluated the Internal Reflectance Sensor developed by EIC, the Cone Permeameter developed by SEA; and the Electrical Resistance Tomography (ERT)/Ground Penetrating Radar (GPR) Tomography developed by ARA funded by Industry Programs.
- Evaluated the SEA Cone Permeameter tested and deployed by the SRS in FY 1998 under funding by Industry Programs.

TECHNICAL TASK PLAN (TTP) INFORMATION

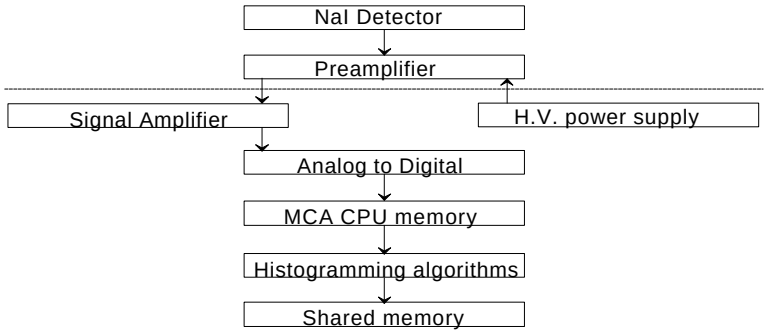
TTP No.: SR16C221 - Site Characterization and Analysis Penetrometer System Logistics

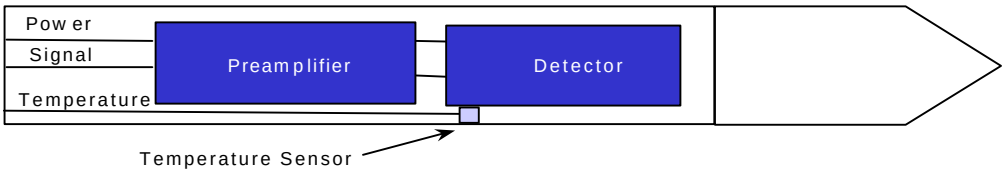
CONTACTS

Carol Eddy-Dilek
Principal Investigator
Westinghouse Savannah River Company
Savannah River Technology Center
Building 773-42A
Aiken, SC 29808
803-725-2418/ fax: -7673
513-529-3218/fax: -1542
e-mail: carol.eddy-dilek@srs.gov

Sharon Robinson
Technical Program Officer
Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802
(803) 725-2378 fax: -3616
e-mail: sharon.robinson@srs.gov

Spectral Gamma Probe





The Spectral Gamma Probe is one of the capability improvements to the Site Characterization and Analysis Penetrometer System (SCAPS).